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Jones, identical with that in his book, "The Siege of Charleston." BURT G. WILDER

BROOKLINE, MASS., December 12, 1913

SCIENTIFIC BOOKS

Researches in Magneto-Optics, With Special Reference to the Magnetic Resolution of Spectrum Lines. By P. ZEEMAN. (Macmillan's Science Monographs.) London: Macmillan and Co., Ltd. 1913. Pp. xvi + 219 + viii plates.

Since the discovery by Zeeman in 1896 of the resolution of spectrum lines in the magnetic field, works have appeared at intervals which summarized the development of the subject to the date of publication. Each of these has been needed when it appeared, partly by reason of differences in treatment by the several authors, but chiefly because of the continuous output of new matter, both on the experimental and theoretical sides; so that an author, by the time his book was off the press, would welcome an opportunity to add numerous footnotes or an extensive appendix.

The investigation of the Zeeman effect during these seventeen years impresses one as having been very ably conducted. The immediate development of the elementary theory by Lorentz gave the phenomenon the place in relation to the theories of light and of electricity which it has ever since maintained. Although the demands on instrumental equipment are severe, the rich field and the close connection with theory caused investigations to be taken up in many laboratories and the requirements have greatly stimulated the development of optical methods. In some cases, theory has predicted a result which at once appeared when the experiment was tried. On the other hand, if one compares the original explanation of the normal triplet with the involved mathematical treatments employed to account for the complex resolutions, the pressure exerted on the theorists by the laboratory results is quite apparent. The development of the theory, however, has been one of growth from a beginning still regarded as sound.

In the book under review, Professor Zeeman

has given us an account, simple in language, largely historical in arrangement, and occasionally touched with personal reminiscence, which records in a highly attractive manner the main features of the investigations started by his discovery. It is in keeping with the title and with the series of monographs to which this book belongs that the author devotes his closest analysis to those features of the phenomenon which have been studied in his own laboratory. This involves the correlation of his results with those of others on these subjects, but other important lines of investigation, such as the application to spectral series, are not omitted.

The first chapter is devoted to the instrumental means employed in the study of the Zeeman effect, especially as regards the efficiency of different spectroscopes in giving the high resolving power required. Emphasis is laid on the three requirements of great resolving power, high magnetic field-strength, and sharpness of spectrum lines for the best results in this work. At the close of the chapter we are reminded of what has occurred to many investigators, that we are near the limit of field strength to be obtained from an iron-cored magnet, and that the hope of great advance, both as to intensity and uniformity of field, lies in the use of a large solenoid. Although the construction of this would require a larger expenditure than has ever been devoted to a single line of physical research, the certainty of the results would seem to make the adoption of the method only a question of time.

The early investigations on emission spectra and the derivation of e/m from the separation of the normal triplet are treated in the second chapter, and the author passes next to the "inverse effect," or the magnetic resolution of absorption lines. This branch of the study must be regarded as still in a preliminary stage. A decided stimulus has been given to the examination of the inverse effect by the discovery of the magnetic field in sun-spots, and much important work, described in a later chapter, has been done by Zeeman himself. The methods are quite different from

those employed with emission spectra and the difficulties arise from peculiar causes. The close analogy of the effects with those of bright line spectra is well worked out, however, and we must admire the skill shown in tracing out the action of polarization of the white light and varying density of the absorbing vapor in altering the effects.

In the following chapters, several branches of investigation of the Zeeman effect are considered in turn. A short account is also given of the related phenomena of magnetic rotation in vapors and magnetic double refraction. The study of multiple resolutions is traced, from the observation that all lines are not normal triplets to the profoundly significant relation of the commensurability of the components given by Runge. Dissymmetries in the resolution and a shift of the middle component are features of the later study which are reviewed by Zeeman.

A chapter on solar magneto-optics summarizes the results of the study of the magnetic field of sun-spots by Hale and of his first observations on the general field of the sun. This is followed by a chapter describing the important experiments of Zeeman and Winawer on the inverse effect in directions inclined to the field. Undertaken because of its application to the solar magnetic effects, this work has been carried out with the highest skill and resourcefulness. Results have been obtained which undoubtedly bear closely on the solar phenomena and can be applied when sun-spots are again in evidence.

The closing chapter of the monograph, on the relation between magnetic resolution and the chemical nature of the elements, may be characterized as a statement of unsolved problems. In it we are made to feel how young the subject of magneto-optics is, and that in some directions the considerable mass of experimental material has served to show that a connection with other departments of knowledge exists but leaves the nature of the relation highly obscure. Thus, the relation between magnetic resolution and arrangement of the lines in series is clear only for a few elements having low atomic weights and few

lines in their spectra. The fact that a series line which is double with no field may change to a simple triplet in the field is an anomaly which affects the whole question of the connection with series relations. There is probably a fundamental relation between magnetic resolution and the pressure effect, but no close correspondence in detail.

A summary of the leading features of several atomic theories and a highly useful bibliography, giving the entire literature arranged according to year of publication, close a volume which will be appreciated by every student of the subject.

ARTHUR S. KING

MT. WILSON SOLAR OBSERVATORY

Mountains, their Origin, Growth and Decay.

By JAMES GEIKIE, LL.D., F.R.S., etc.
Edinburgh, Oliver and Boyd. 1913. Pp. 311, 80 Pl., 57 Figs. in text.

This volume contains in systematic form the substance of various contributions made by Professor Geikie during the last twenty years, supplemented with much new matter. The author recognizes two classes of mountains, original or tectonic, and subsequent or relict.

Tectonic mountains are due to accumulation or deformation; the former includes the various types of volcanoes as well as glacial and æolian hills; all of which grow by additions to the outside; the latter includes folded, dislocation and laccolith forms, all due to crustal disturbance. The study of tectonic mountains occupies by far the greater part of the work, which is intended to be a non-technical presentation of the subject. Such matters as glacial action, metamorphism, types and causes of folding, structure of the Alps, origin of ocean "deeps" are discussed as simply and easily as though they were familiar topics of every-day conversation. Certainly, this mode of treatment shows that exact scientific method does not require much aside from ordinary language, for one knowing only the general principles of physics and geology can grasp the situation so as to appreciate the difficulties with which an investigator must contend as